
Space Weather Technical Forecast

Issued on Monday, 16 September 2024 at 13:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

From the 24th of September, the way we distribute this forecast is changing and you will need to take action to continue receiving it. You should have received an email on the 4th of September explaining the steps required to do this. If you have already signed up to receive the forecast on our premium website, please disregard this message. If you haven't, or if you need help with the process, please contact moswoc@metoffice.gov.uk

Space Weather Forecast Headline: Chance of M-class flares. G1-G2/Minor-Moderate Geomagnetic storms expected 16-17 Sep, with a chance of G3/Strong storm intervals and slight chance of peak G4/Severe storm conditions due to a forecast fast CME arrival.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low with only C-class flares observed. There are eight sunspot regions on the disc with the most active being AR3825 (Eac/Beta-Gamma) in the southeast. It remains a compact and complex region, but appears to have lost its delta spot in the trailing portion of the group. Growth has been limited and generally confined to the leading region. AR3824 (Esi/Beta-Delta) in the southwest exhibited slight growth, including development of a small delta configuration in the largest trailer spot. Minor growth of AR3822 (Cro/Beta) in the northwest was observed, as well as the emergence of a simple, bipolar group to the east of this region. Two regions rotated over the southeast limb, with one numbered AR3827. Both appear to be mature, simple, unipolar groups, but may reveal more complexity as they come into clearer view. The remaining sunspot groups observed slight decay or were stable.

No new Earth-directed CMEs have been observed.

Solar Wind / Geomagnetic Activity: Solar wind parameters, as observed by ACE at L1, were somewhat enhanced during the period, with wind speeds erratic and varying between 400-580km/s (slightly elevated to elevated). Density was generally below average, but occasionally reached average levels later in the period. The Interplanetary Magnetic Field (IMF) Bt, was largely steady, and Weak to Moderate in strength, between 6-8nT, but increased from 16/0500 UTC to mostly range between 8-10nT, perhaps attributed to a weak connection to the high-speed stream of CH69/+. The north-south component, Bz, was also erratic, but often negative, peaking near -10nT at 16/0932 UTC. Phi angle was largely positive (away from the Sun). The net result of these parameters was for Quiet to Active geomagnetic activity (Kp 2-4).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 is above normal background levels following the X4.5 flare on 14 Sep, but remains below the S1/Minor Storm threshold. High energy electron flux (greater than 2MeV) observed by GOES16, generally varied on a diurnal cycle between background to high, peaking at 1690pfu (High levels) at 15/1605 UTC. The associated 24-hour fluence showed a generally flat trend, with 5.8e7 integrated pfu observed at 16/0000UTC.

Four-Day Space Weather Forecast Summary

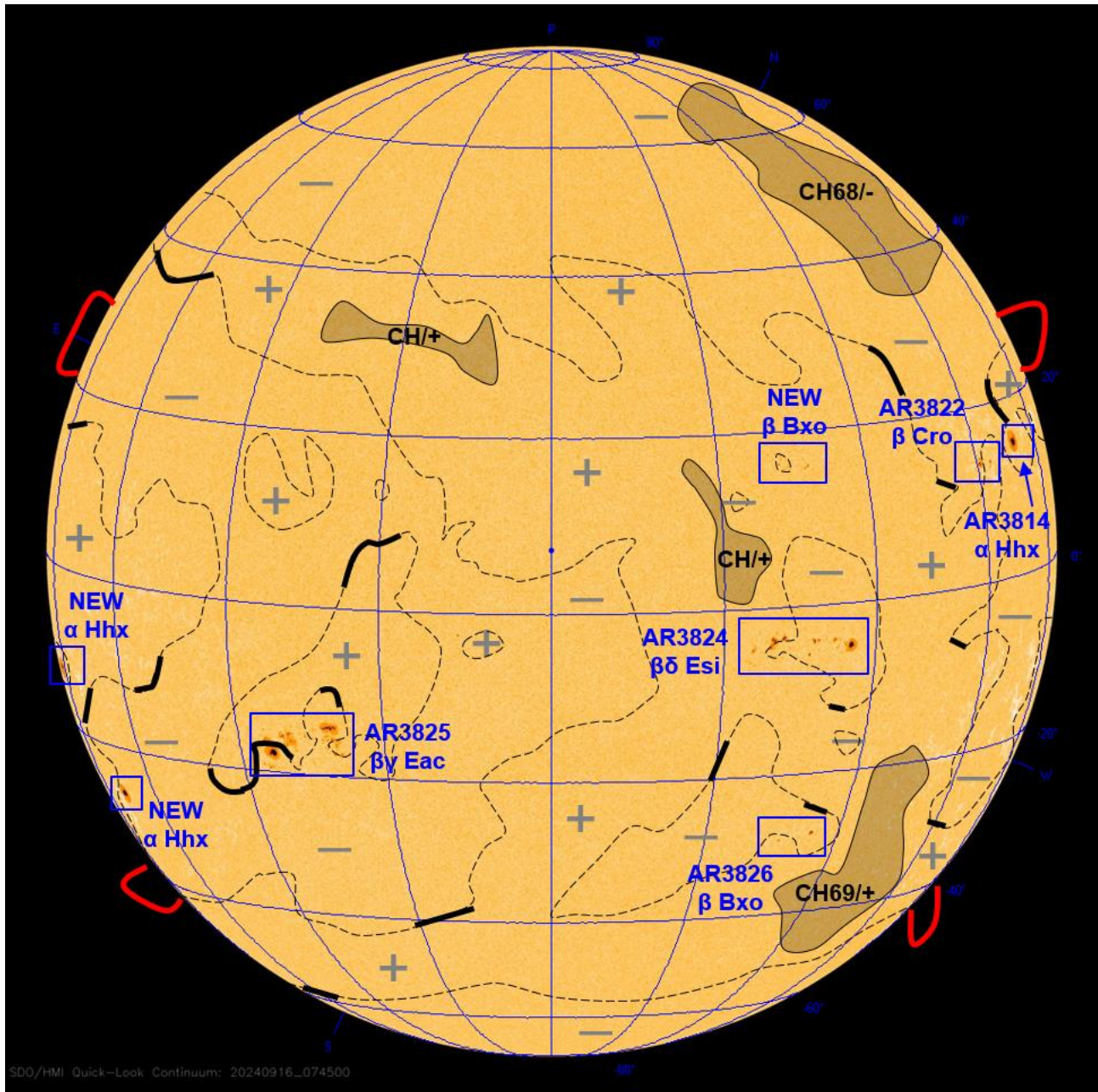
Solar Activity: Low to Moderate activity is forecast, with a chance of M-flares, most likely from AR3824 or AR3825. There is a slight chance of an isolated X-class flare from AR3825.

Solar Wind / Geomagnetic Activity: There are up to two CME arrivals and up to two coronal hole fast winds which feature in the forecast. The most significant feature is the 14 Sep CME which may bring Strong or Very Strong solar winds at Earth on day 1 (16 Sep). This feature is likely to have lingering effects into day 2 and 3 (17 and 18 Sep) combined with the first coronal hole fast wind. A second coronal hole fast wind may arrive day 3 or 4 (18 or 19 Sep), with slightly elevated to elevated speeds possible.

Until the arrival of the CME on day 1 (16 Sep), geomagnetic activity is forecast to be between Unsettled and G1/Minor Storm levels. Following the CME arrival persistent G1-G2/Minor-Moderate storming is expected, but with a high chance of peak G3/Strong storm levels and a slight chance of G4/Severe storm intervals occurring. These risks gradually decrease between days 2 and 4 (17 and 19 Sep) due to waning CME and coronal hole fast wind effects.

Energetic Particles / Solar Radiation: High energy proton flux at GOES-18 is above normal background levels following the X4.5 flare on 14 Sep, but remains below the S1/Minor Storm threshold. There is still a chance that S1 proton storm levels may be reached day 1 (16 Sep), this risk reducing later in the period. High energy electron flux is expected to rise to diurnally Moderate to High levels ahead of the CME arrival from 14 Sep flare, reducing to mainly background levels thereafter. The associated 24 hour fluence is likely to remain below Active (1e8pfu integrated flux) threshold, but with a chance of exceeding this threshold on day 1 (16 Sep).

Figure 1. Solar Analysis Valid 16/0745 UTC.



Key: Filament —, Prominence —, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

A CME was observed leaving the sun at around 13/0930 UTC, the result of a filament eruption, most likely associated with the M2.9 flare observed at 13/0835 UTC from AR3814. Its analysis revealed that the bulk of the ejecta is expected to pass ahead of Earth's orbit towards Stereo-A, however it may still give a glancing blow on day 1 (16 Sep).

The most significant CME in the period originated from the X4.5 flare from AR3825 at 14/1528UTC. This spot was located around 55 degrees east at the time of the eruption, with subsequent analysis showing significant material being ejected directly away from the source in a narrow cone, but with a wider region of material also evident, this has been modelled with an arrival at Earth most likely during day 1 (16 Sep). At the time of writing this CME is yet to arrive at L1.

Aside from these arrivals, there are also up to two coronal holes which may influence the forecast. CH69/+ in the southwest may connect on day 1 (16 Sep). A minor enhancement in solar wind parameters around 16/0500 UTC could be related to this. Confidence is low however, due to its southern location and Earth currently being above the solar equator in its orbit, although Enlil has consistently forecast elevated to strong solar winds (around 500-600km/s) from this feature. Finally, a small positive coronal hole west of centre disc may bring slightly elevated to elevated wind speeds at Earth for a time. This is most likely to occur on days 3 and 4 (18 and 19 Sep).

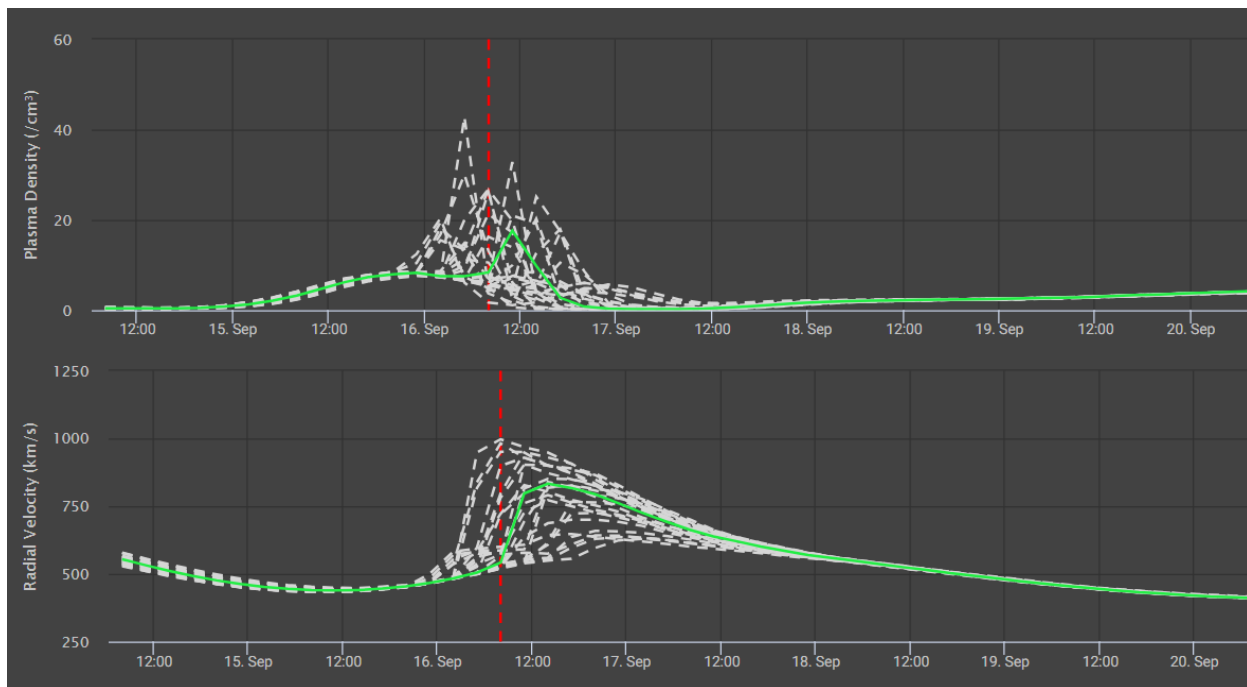
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Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	90	80	30	10
Strong	G3	No	45	25	5	1
Severe	G4	No	15	5	1	1
Extreme	G5	No	5	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
14/1818	Partial	X4.5 flare AR3825	SE	1250km/s	16/0600 UTC -6/+12hrs	Arrival delayed compared to initial expectations

Figure 2. Latest MOSWOC Enlil Ensemble indicating potential CME arrival times



Radio Blackouts - X-Ray Flares:

There are eight sunspot regions on the disc, including two unnumbered regions. A large, mature spot has recently rotated into view in the far southeast and may reveal more complexity as it comes into clearer view. The spot to the southwest of this, also in the southeast disc, has been numbered AR3827.

The largest sunspot, AR3825, located in the southeast evolves slowly, with some growth of minor polarity spots in the leading portion of the group, but slight decay in the trailing region, including the loss of the previous delta configuration. It remains a compact region, with notable north-south aligned opposing polarity spots in both leading and trailing portions, increasing instability and potential for significant flares, despite its recent inactivity. AR3824 in the southwest continues to develop slowly, with growth observed in the trailing portion that also contains a small north-south aligned delta configuration. AR3822 in the northwest is showing slow signs of growth, with rudimentary penumbra maintained around the trailing portion of the spot. The remaining regions are generally small and stable, with limited magnetic complexity.

There is a chance of M-class flares, with a slight chance of isolated X-class flares, most likely from AR3825.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	45	45	40	40
Very Active	R3 to R5 X Class	No	10	10	10	10

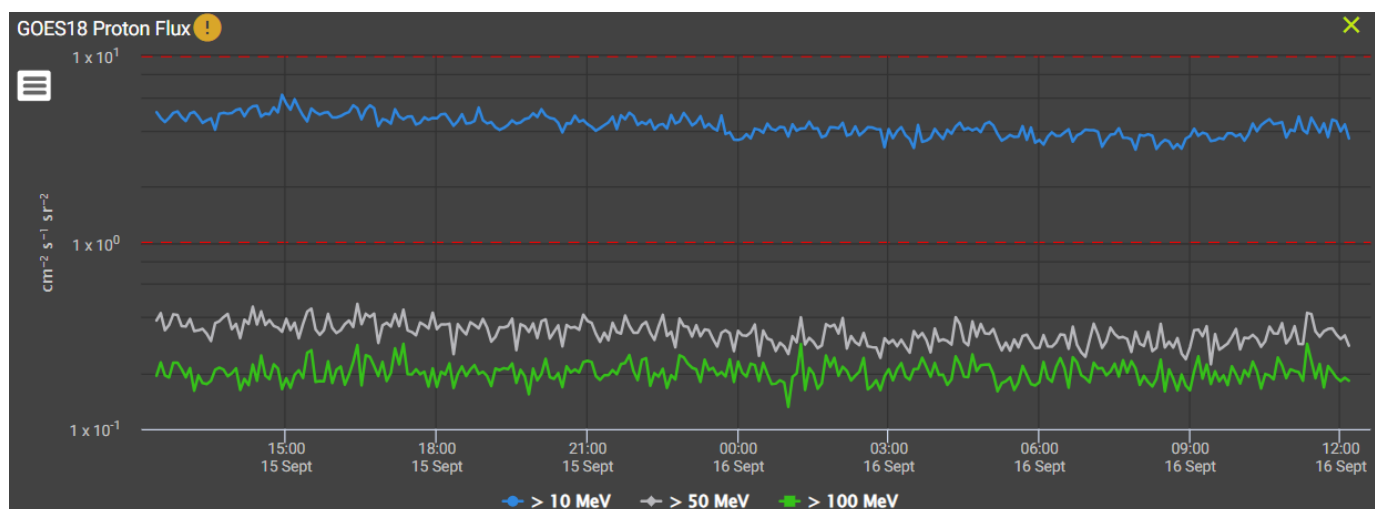
Solar Radiation Storms - (High Energy Protons):

High energy proton flux at GOES-18 is above normal background levels following the X4.5 flare on 14 Sep, but remains below the S1/Minor Storm threshold. A near flat trend is now being observed, but there remains a chance that S1 proton storm levels may be reached day 1 (16 Sep) following the arrival of the 14 Sep CME. This risk reducing later in the period to a slight chance in the absence of any further notable flaring.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	30	20	10	10
Very Active	$\geq \text{S3}^*$	No	1	1	1	1

* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)

Figure 3: GOES-18 Proton Flux



High Energy Electrons Event ($\geq 2\text{MeV}$):

The high energy electron flux has risen to High levels during the diurnal maximum due to recent geomagnetic storming that took place on 12 Sep. Now with up to two further CME arrivals anticipated and up to two coronal hole fast wind arrivals in the period, any rise is expected to be brief and the high energy flux most likely to return to mainly Background levels.

The associated 24-hour fluence is likely to remain below the Active level, but with a chance of exceeding this threshold on day 1 (16 Sep) ahead of the forecast main CME arrival. The latest MOSWOC REFM output is currently showing a generally steady fluence forecast rise, above the Active threshold on day 2 (17 Sep), however this isn't taking into account any CME impacts or possible coronal hole interactions in the coming days.

GEO Electron Environment	Level ($\text{cm}^{-2}\text{sr}^{-1}\text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2\text{ MeV}$ $\geq 1 \times 10^8$	No	30	5	1	1
Very Active	$\geq 2\text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1



Figure 4: GOES-16 >2MeV Electron Flux (top) and MOSWOC REFM and recurrence output (below)

